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GEORGE VIVIAN POORE, M

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[Excerpt from Vol. IX. of the Transactions of the Sanitary Institute of Great Britain.]

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ANNUAL ADDRESS.

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OF

SOME MODERN SANITARY METHODS.

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GEORGE VIVIAN POORE, M.D., F.R.C.P.

July 14*th*, 1887.

OFFICES OF THE INSTITUTE:
74A, MARGARET STREET, REGENT STREET, W.

ON THE SHORTCOMINGS OF SOME MODERN SANITARY METHODS.

Address by G. V. Poore, M.D., F.R.C.P.

Anniversary Meeting, July 14th, 1887.

I have been for some years so strongly impressed with the shortcomings of one of the chief methods of modern sanitation that I felt bound, when the Council of the Sanitary Institute did me the great honour of requesting me to deliver the annual address, to choose for my subject that which was uppermost in my mind.

The chief aim of sanitarians has ever been, and ever will be, the securing for the masses of the people the two chief necessities of life—pure air to breathe, pure water to drink. Whether or not we are able to secure these two necessities depends very largely upon the method which we adopt for the treatment of putrescible refuse, and it is on this point, and on the modern fashion of mixing putrescible refuse with water, that I propose to address you.

It may be well to remind you that all dead organic matter is putrescible, and, when I speak of putrescible matter, I mean all organic matter, inclusive of excrement.

Nature moves in a circle, animals feed on each other and on vegetables, vegetables feed on the dead bodies of animals and vegetables, and on the solid and gaseous excrements of animals. Animal and vegetable life are complementary, and mutually support each other. This is a law of nature, and when I make this assertion I feel I run no risk whatever of being contradicted.

The laws of nature are inexorable; *i.e.*, they are not to be set aside by human prayers—not even by that best of all prayers, labour. Those who disobey the laws of nature, or who enter into a contest with her, are sure to be worsted in the end. If we fight with nature we court calamity.

I have elsewhere compared those who fight with nature to Sisyphus, who, according to the old mythology, was condemned

in the lower world to a never-ending contest with the force of gravity—

> With many a weary sigh and many a groan,
> Up the high hill he heaves a huge round stone;
> The huge round stone resulting with a bound,
> Thunders impetuous down, and smokes along the ground.

By means of great expenditure of time and money, we may wage for a period with nature a war which may be apparently successful. The war can never be really successful, it will never terminate, nature in the end will assert her eternal sway, and crushing defeat must be our lot.

As the inevitable destiny of putrescible matter is to become the food of vegetables, a destiny which we can delay at the most only for a brief period, our proper course in dealing with it is clearly not to attempt to prevent or even to delay the inevitable. Such a course is to disobey the laws of nature, to fight with her and court ultimate defeat. Our wiser plan is to help nature in her work, and thus win her smiles.

It has been the wise custom in all ages of the world to dispose of putrescible matter by burial in the earth. Dead bodies have in all ages been buried, and the greatest of all lawgivers and sanitarians, Moses, whose likeness rightly takes the place of honour in this room, gave most explicit directions that excremental matters should be treated in the same way.

This is a not unimportant fact, and although we do not in this country follow the whole of the Mosaic law, nevertheless that law is so pregnant with marvellous wisdom that we ought not to discard any item of it without first questioning ourselves most strictly as to our reasonableness in so doing. The latest advances of modern science seem to show that in this particular Moses was absolutely in the right.

It has been shown, I think, conclusively that the decomposition of organic matter, whether in the earth, air, or water, is brought about by minute fungoid organisms, the growth of which has the effect of resolving the highly complex organic compounds into soluble salts or gaseous bodies, which can be absorbed by the roots of plants.

Now when putrescible matter is buried in the earth it undergoes decomposition without the occurrence of putrefaction—that process which is at once offensive to the senses and dangerous to health. This is effected by means of mould fungi, which produce oxidation of the organic bodies. If sufficient air has access to the pores of the soil, and if sufficient moisture be present, the nitrogen takes oxygen to form nitric acid, which, combining with the bases, forms soluable nitrates, and the

carbon also combining with the oxygen forms carbonic acid, which, combining with the bases, forms carbonates.

The best account which I have been able to find of the active organisms which are ever present in the soil, is in a paper by Professor Wollny,* of Munich, which was brought to my knowledge by my friend, Dr. E. F. Willoughby. These organisms are so incalculably numerous that their activity must be exceedingly widespread. Koch found enormous quantities, even in winter, in the soil not only of crowded places like Berlin, but in that also of remote fields. At the observatory of Mont Souris 750,000 were found in a gram of earth, and at Genevilliers from 850 to 900,000.

If the action of the microbes be checked by antiseptics, the vapour of chloroform or heat (100°c), the chemical changes in the earth cease.

That the formation of nitrates and carbonic acid from organic matter in earth to which air has access is due to microbes has been proved by direct experiment. When, however, organic matter is mixed with earth, and air is admitted in insufficient quantity or entirely excluded, the decomposition is of another kind; and besides small quantities of carbonic acid and carburetted hydrogen, there is formed water, ammonia, free nitrogen, and a great quantity of a black carbonaceous peat-like matter (the so-called sour humus).

Schlösing found that the nitric acid in the soil disappeared when the air was replaced by nitrogen.

The kind of organism seems to vary with circumstances. As long as air is freely admitted, the mould-fungi (schimmelpilze) preponderate; and when air is excluded, the schizomycetes (spaltpilze) increase.

The formation of nitric acid in organic earth mixtures depends on the amount of oxygen which is present in the air admitted. Thus Schlösing found by experiment that the formation of nitric acid varies as under:—

Oxygen	1·5%	6	11	16	21
Nitric Acid	45·7 m.g.	95·7	132·5	246·6	162·6

The nitrification which took place with a limited supply of oxygen was due probably to the air already mixed with the earth before the experiment began.

Miller and Boussingault have shown that no nitrification takes place in thoroughly soaked earth to which little air has access, and that when oxygen is absent the nitrates in the earth are

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* "Ueber die Thätigkeit niederer Organismen im Boden." Deutche Vierteljahrsschrift für offentliche Gesundheitspflege, Vol. 15, 1883, p. 705.

reduced. The formation of carbonic acid also depends upon the admission of air (containing free oxygen), but some carbonic acid is formed even though all air be excluded.

Oxygen in air	Pure N	6%	11%	18%	21%
Carbonic acid	9·3 m.g.	15·9	16	16·6	16

Nitrification is assisted by a moderate amount of moisture. It attains its maximum when the moisture reaches 33 per cent., and above and below this the process of nitrification and formation of carbonic acid is hindered.

Temperature has a great influence on oxidation in the earth. It reaches a maximum, with a temperature of about 50° C., (120 F.) and stops at 55.

Oxidation goes on most quickly in the dark.

Thus, oxidation depends not only on the presence of the organisms, but also on the presence of other factors, such as suitable aeration, suitable moisture, suitable temperature.

These factors may all be suitable, or some may suit and others may not suit the oxidation process.

The decomposition of organic matter in the soil is governed by that factor which is at its minimum.

The process of decomposition is much influenced by the physical condition of the soil, as, *e.g.*—

(a.) Permeability for air and water.

(b.) Nature and permeability of subsoil.

(c.) Slope.

(d.) Aspect.

(e.) Warmth dependent on aspect, mineral composition, colour and moisture and nature of the crop. Barren soils are warm, while those covered with green crops are cool.

That the variations of the ground water have a bearing on the oxidation processes cannot be doubted, when we reflect that the soaking of the upper layers of the earth is much influenced by the height of the ground water. When all the layers of earth are soaked, putrefactive processes, through the medium of Schizomycetes, take place. When the ground water falls, and the air again enters the pores of the soil, the growth of those organisms is favoured, which assist in the oxidation of the soil."

All changes which organic matter undergoes in the earth are thus seen to be brought about, almost exclusively, by the life of lower organisms the activity of which is ruled by the same natural laws which govern the growth of higher plants.

There can be no better illustration of the true economy of nature than this action of the microbes in the soil on the conversion of organic matter into soluble salts and gases which serve as food for plants.

The growth of the microbes depends upon the concurrence of those conditions which, by experience, we all know to be favourable to the growth of higher plants. There must be a good supply of free oxygen, sufficient, but not too much moisture, and a summer temperature. In well-tilled ground, broken up so as to admit air to its pores, and in a "fine growing season," in which sunshine alternates with showers, this process of oxidation is at its maximum. The microbes are active beneath the surface manufacturing plant food from organic matter, and the favourable conditions above soil and below cause a vigorous growth of crops.

When, on the other hand, the weather is unfavourable, and when in consequence of excessive cold, excessive drought, or excessive wet, crops are not developed as they should be, the microbial life is also checked, and the change of the organic matter is delayed, and it is stored up for future use in more favorable seasons. This is the explanation apparently of the fact well known to farmers, that the effect of organic manures is more permanent than that of the so-called artificial manures, which at present are so much in vogue. The organic manure remains entangled in the soil, and is not readily washed out of it in winter when the temperature is low, or even in unpropitious summers. It cannot be washed out until microbial growth has changed it into soluble salts, and when this change takes place, which it does in "good" weather, the roots of the growing plants seize hold of the ever-forming soluble salts and appropriate them to their own use. In fact the farmer who uses organic manures from the farm-yard or elsewhere, need trouble himself very little with agricultural chemistry or experiment.

He may feel certain that if he buries his organic manure *directly it is produced* it will not be wasted. It will not give off ammonia to the air, nor will the juices be washed away by rain to the same extent as when it is left above ground to be a nuisance. There seems to be no doubt whatever that all heaps of manurial matter which give off ammonia and other gases to poison the air, and perhaps do more serious mischief which we "know not of," are allowing valuable matter to escape, which ought to be undergoing oxidation in the earth. There can be no doubt whatever, that to the agriculturist stink means waste, and it is to be hoped that when the bucolic mind has imbibed this great and important truth, the country will be more evenly pleasant than it is.

The reason why farmers allow putrescible matter to fester in heaps appears to be—

1. That the matter has to wait until land is clear and circumstances permit of its being dragged to the fields; and (2)

that when the matter is thoroughly rotten and most offensive, a *more rapid and visible* result is produced, notwithstanding that the total result is probably less than if it had been applied to the ground at once. It is certain that putrescible matter intended for manure must waste more above ground than when buried immediately beneath it. Rich farmers are now building sheds over their yards to prevent the access of rain to the manure, and are providing tanks for the reception of liquid which drains away. This involves a very great expense, and it is at least doubtful whether the result is better than that got by the immediate application of such matters to the soil—a process which involves no extra expenditure of any kind—a most important matter, because the only acceptable test of good husbandry is the balance sheet.

Mr. Warington, F.R.S., in his valuable little book on "The Chemistry of the Farm," says, "The most complete return to the land would be accomplished by manuring it with the excrements of the men and animals consuming the crops" (p. 28); and again, "Farmyard manure is a 'general' manure; that is, it supplies all the essential elements of plant food. * * The effect of farmyard manure is spread over a considerable number of years, its nitrogen being chiefly present not as ammonia, but in the form of carbonaceous compounds, which decompose but slowly in the soil."

The immediate return is often less than when artificial manure, consisting of soluble nitrates and phosphates is used, but the important point seems to be that the return is tolerably sure to come in the long run.

The late Professor Voelcker, in the article, "manure," in the "Encyclopædia Britannica," gives an interesting table of the experiments of Sir John Lawes and Dr. Gilbert, spreading over a period of 24 years, in which is shown the effect of different manures on crops. The most successful results with artificial manure were got by applying nearly 1,400 lbs. weight per acre of mixed ammonia salts, superphosphate and sulphates (potash, soda, and magnesia). With this manure there was an average production of 37½ bushels of wheat, weighing on an average 59 lbs. per bushel, and multiplying these two figures together we may say that the production of wheat averaged 2,212·5 lbs. The production of barley averaged 41½ bushels, weighing 53⅜ lbs., and multiplying these figures we may say that the average production was 2,588 lbs. Where the land was manured with 14 tons of farmyard manure the average production of wheat was 35¼ bushels, weighing 60 lbs., giving a figure of 2,115 lbs., and of barley, 48¾ bushels, weighing 54⅜ lbs., giving a figure of 2,650 lbs.

This farmyard manure, when used for wheat growing, gave a yield of 97 lbs. less than when the best artificial manure was used; and when used for barley growing it gave 62 lbs. more than when artificial manure was used. These figures are certainly not such as should discourage us in the use of farmyard manure, especially when we remember that the average agriculturist is not likely to apply his artificial manures with the knowledge and judgment of Messrs. Lawes and Gilbert; and that in the use of farmyard manure it is not easy for him to go very wrong. Again, farmyard manure is stuff which *must* be used, while chemicals are things which *must* be bought, and need to be analysed when bought.

It is a great mistake to suppose that farming is in any way comparable to a chemical experiment. In experiments conducted in the laboratory the chemist is able to control *all* the conditions of the experiment, but in farming the condition which above all others influences the result, viz., the weather, cannot be controlled.

When chemical manures are used with judgment and applied at the right moment, and when the weather is favourable, there is no doubt that the result is often surprising and gratifying. When however the weather is unfavourable, when the drought is so great that the chemicals cannot be dissolved, or when the rain is so heavy that they are washed out of the soil, the result is not encouraging. If organic manures are used, they do not waste in bad seasons, and much remains in the ground for next year's crop. The farmer however who applies chemicals in a bad season, gets neither crop nor residuum of manure for next year. Mr. Warington says that "farmers have a prejudice in favour of the latter (*i.e.*, organic) manures, but it is clear that the quickest return for capital invested is afforded by the former class" (*i.e.*, inorganic).

Surely we have no right to blame the farmers for their prejudice, which seems to be in all respects reasonable. The doctrine has obtained in this country of late years that it is good economy to waste all our home-grown organic manure, and to import chemicals from South America for the purposes of agriculture. This is a strange doctrine; but as most of our farmers are now too near bankruptcy to pursue this course, we may hope that ere long they will begin to clamour for that which we now waste so wickedly.

One more word before I bring my remarks on farming to a close, remarks for which I make no apology, for I feel sure you must already recognise their bearing on the subject of sanitation.

The remark I have to make is this, that in the hands of Lawes and Gilbert farmyard manure gave better results with

barley than with wheat. May not the fact that farm animals are largely fed with barley-meal, have something to do with this. There are experiments which show that minimal ingredients in manures are not without effects which are often surprising. There are *a priori* grounds for thinking that the best manure for barley must be the excrement of a barley-eating animal, for in that excrement must be all that is necessary for barley. I wish some agriculturist would make the experiment of growing wheat with the excrement of a wheat-eating or bread-eating animal. As a gardener I have grown potatoes with the excrement of a potato-eating animal, and certainly the result has been most encouraging.

I have been obliged to draw my illustrations as to the practical result of burying organic matter from the agricultural employment of farmyard manure, because facts based upon exact experiments with the organic refuse of our towns is not forthcoming.

What I want to insist upon is this, that the proper destiny of organic refuse is immediate burial just below the surface of the soil.

Most of the shortcomings of modern sanitary methods are due to the fact that in our dealing with organic refuse we commit a scientific error, *i.e.*, we pursue a course which is in opposition to natural law.

This error consists in mixing organic refuse with water.

When organic refuse is mixed with water, it undergoes changes which differ widely from the changes which it undergoes when mixed with earth.

According to Wollny whose paper I have quoted previously, the process of oxidation of organic matter and the formation of nitrate takes place most readily when a moderate amount of moisture is present. The most favourable amount is about 33 per cent., and if the moisture rise above or sink below this amount, the process of nitrification and the formation of carbonic acid is hindered. When water is in excess the amount of free oxygen is insufficient to favour the growth of mould fungi, the schizomycetes (Bacteria and Micrococci) are formed, and in place of oxidation, putrefaction takes place with the formation of ammonia, free nitrogen, carbonic acid, and carburetted hydrogen. Under these unfavourable circumstances it is possible that the nitrates which may have been formed may be again reduced.

This process of de-oxidation takes place in mixtures of putrescible matter with water, and takes place also, it is said, in soil which is thoroughly soaked with sewage (*i.e.*, putrescible matter mixed with water). In the face of these facts it is not to be

wondered at that "sewage farming," which is farming under acknowledged difficulties, has not proved a commercial success. We must indeed be in doubt whether, when the circumstances are more than usually unfavourable, it exercises any very great purifying action upon the putrescible mixture. In the treatment of putrescible refuse, so that it shall not be a danger or annoyance, what we have to aim at is nitrification rather than putrefaction, and it is certain that by mixing with water putrefaction is encouraged and nitrification delayed.

It certainly seems to be almost incontestable that the proper course to pursue with regard to organic refuse—putrescible matter—is the very reverse of that which we do pursue. We clearly ought to encourage oxidation, and make putrefaction impossible.

Putrefaction is certainly a great cause of ill health. It was the putrefaction of wounds (now happily almost unknown) which converted our hospitals into something little better than charnel houses. It is the putrefaction of organic refuse mixed with water in cesspools and sewers that causes that long list of ailments which we ascribe to the inhalation of "sewer air."

The opinion is held by many that the dejecta of typhoid patients and cholera patients do not become dangerous to others until putrefaction has set in, and such an acute observer as was the late Dr. Murchison held the opinion that common putrefactive changes taking place in dejecta were a sufficient cause of typhoid, independently of the admixture of any specific poison.

The putrefaction of organic refuse, when mixed with water, has, I think, been the chief cause of the development of modern sanitary "progress." Our forefathers were not given to this method of treating putrescible matter. House-slops trickled along open gutters, and excremental matters were deposited in dry pits. At the beginning of this century the water-closet came into use.

Mr. W. Haywood, quoted by Dr. Farr, says, "Water-closets were invented about 1813, and became general in the better class of houses about 1828-33. The custom at first obtained of building cesspools having overflow drains put below their doming, by which means the solid matters were retained, and the supernatant liquid only ran off.

"In the year 1849, what may be said to be an organic change in the system took place. In 1848 the City Commission of Sewers obtained its Act for sanitary purposes, which became operative on January 1st, 1849, and then for the first time was discharge into the sewers legalised. Previously a penalty might have been enforced for such a usage of them, but henceforth, within the City of London those incurred a penalty who

failed, upon notice, to construct the drainage of premises in such a manner as not to discharge all waste waters *and fæcal matters directly into the public sewers* [*i.e.*, directly into the sources of water supply] of which the full utility was therefore for the first time recognised by statute. This Act was speedily followed by others for the remaining area of the metropolis and for the entire country."

"It will be noticed," says Dr. Farr, "that the deaths from cholera and diarrhœa increased in London in 1842, increased still more in 1846, when the potatoe crop was blighted, and in 1849 culminated in the epidemic of cholera.

Dr. Farr says further, "a system of sewerage is the necessary complement of a water-supply."

"Almost coincidently with the first appearance of epidemic cholera, and with the striking increase of diarrhœa in England, was the introduction into general use of the water-closet system, which had the advantage of carrying night soil out of the houses, but the incidental and not necessary disadvantage of discharging it into the rivers from which the water-supply was drawn."

Mortality per 1000 from diarrhœa in London (Dr. Farr):—

1838	·215	1853	1·011
1839	·201	1854	1·257
1840	·238	1855	·804
1841	·238	1856	·866
1842	·353	1857	1·181
1843	·410	1858	·759
1844	·340	1859	1·211
1845	·397	1860	·496
1846	·997	1861	·928
1847	·898	1862	·607
1848	·853	1863	·821
1849	1·705	1864	·981
1850	·813	1865	1·206
1851	1·085	1866	1·306
1852	·983	1871-80—Dr. Ogle	·940

Thus in the decade 1871–80, 33,168 persons died of diarrhœa in London, the death-rate from this cause being ·94

If the death-rate of 1838 (·215) had obtained in the decade 1871–80, the deaths from this cause would have numbered only 7,600, and there would have been a saving of 25,568 lives.

Since the introduction of the water closet, and I believe as a direct consequence of it, we have had four severe epidemics of cholera, a disease not previously known, and enteric or typhoid

fever, previously almost or quite unrecognised, has risen to the place of first importance among fevers in this country.

The evils which have arisen from cesspools and sewers has caused an enormous amount of attention to be devoted to what are known as "sanitary appliances," sewer constructions, &c., and so great and so well recognised are the evils of sewers that many of our friends are anxious that we should be compelled, by Act of Parliament, to protect ourselves from the mischief which previous Acts of Parliament have produced.

Not only does the putrefaction of organic refuse tend to fill the air of our houses and towns with foulness, but this mixture of organic matter with water is attended with other bad consequences.

This arises from the fact that much of the organic matter which we mix with water is distinctly poisonous. The zymotic theory of disease has of late years assumed more definite shape, so that we may now leave what was called the zymotic *theory* and consider the actual facts.

There is no doubt that the actual infective elements of many zymotic maladies consist of microbes, fungoid bodies belonging to the class of fungi known as Schizomycetes, that class which grows in organic mixtures where insufficient free oxygen is present.

These microbes are infinitely small; millions of them may live in a cubic inch of putrifying liquid. Under favourable circumstances they will live for long periods. They will not only live but multiply, and it is at least a question, and a grave one, to what extent these infective germs undergo an increase when mixed with organic liquids such as sewage or milk?

The fact that the zymotic poisons are *particulate and alive* is one which has most important bearings on the subject under discussion. If the poison were a chemical poison, then dilution would practically do away with its power for harm. No amount of dilution is capable of destroying a zymotic poison, in fact it is not impossible that the mere mixing of organic refuse which contains a zymotic poison with water may be the means of keeping it alive and possibly causing it to multiply.

When a mass of organic matter, charged with zymotic particles, is mixed with water and washed out of a house, the water will carry the poison with it wherever it may chance to flow or trickle, to water course, well, or any other source of drinking water; in fact the dissemination is as perfectly and thoroughly done as if dissemination of poison were the main object which we had in view.

When dealing with organic matter impregnated with zymotic

poisons, mere dilution with water increases rather than diminishes the danger.

As long as the poisonous organic refuse is concentrated, its repellent qualities are such that there is little chance of its gaining access to the human body. The microbes contained in it are theoretically capable of infecting an almost indefinite quantity of water, and this large quantity of water masks the repellent qualities of the stuff, and thus the danger of infection is greatly increased.

This dissemination of poison by water is one of which we have had very bitter experience in this country.

There is little room for doubt that, in this country at least, water has been the great carrier and disseminator of the poison of cholera.

In 1849 the mortality in London was highest in those districts getting their water supply from the Thames between Battersea and Waterloo Bridge.

In 1853-54 the same phenomenon was observed. In 1866 the chief mortality was in the district supplied with water taken from the river Lea. With regard to this latter epidemic, we are in possession of many details, and the following is a summary of the facts as given by the late Dr. William Farr in his report on the cholera epidemic of 1866 :—

"Several cases of cholera and choleraic diarrhœa had occurred over London in May; and on 27th June, at 12, Priory Street, Bromley, one poor Hedges, a labourer, and his wife, both of the age of 46 years, died of 'Cholera Asiatica,' the former after 15, the latter after 12 hours' illness. These cases are minutely described by Mr. Radcliffe, who traces the discharges into a water closet of 12, Priory Street, and thence 300 yards down the sewer into the Lea (a tidal river which ebbs and flows) at Bow Bridge, half a mile below the Old Ford reservoirs. He attaches great importance to these first cases, and they undoubtedly sufficed to pour into the sewers and waters millions of zymotic molecules, which day by day grew more and more frequent in the Lea, by every hour's choleraic discharges on both sides of the river." A few days later water was supplied to the district from a reservoir, the bottom of which was pervious cholera waters of the Lea, and then resulted an outbreak of to the and diarrhœa which caused the death of over 4000 persons.

I need not give further instances of the dissemination of disease by water-carried sewage, sanitary literature is full of them.

What is true of cholera is also true of typhoid, and I will only say in reference to this subject that (if we accept, as we are

bound to do, the statements put forward with regard to the cholera epidemic of 1866), if the excreta of the Hedge's family had been buried or burnt, the waters of the Lea would not have been infected, and possibly 4,000 lives would have been saved.

The first principle in dealing with epidemic disease is that which is expressed in the words, *principiis obsta*, resist the beginnings. The object of this is evident, and is well expressed by Shakspere in the words—

> "A little fire is quickly trodden out,
> Which, being suffered, rivers cannot quench."

The mixing with water may be looked upon certainly not as a resistance of the beginnings, but rather as a nursing and favoring of them, which, "being suffered," most surely "rivers cannot quench."

The great principle of *principiis obsta* has been most rigidly observed by surgeons in dealing with those forms of blood-poisoning which arise in connection with wounds, and which were known as hospital diseases. To Lister belongs the credit of recognising that the great thing to be aimed at was the checking of putrefactive changes in the discharges from the wound, an end which has been attained by adopting what are known as antiseptic precautions in the treatment and dressing of wounds. A foul wound is looked upon as a great source of danger to the patient himself, and formerly the poisons generated in the wound of one patient were carried by sponges and instruments (which, be it remembered, were "*clean*," as far as any indications appreciable by our unaided senses were concerned) to the wounds of others; and thus it followed that the mortality from what was wrongly spoken of as "hospitalism" was enormous. Now, however, putrefaction in wounds is practically at an end, owing to the use of antiseptics and to an improved appreciation of what cleanliness really means; and, as a result of this, hospitalism has disappeared.

How marvellous have been the results which have followed on the adoption of the principle of preventing putrefaction in wounds is well shown in a table given in the last edition of "Erichsen's Surgery." This table is taken from a statistical work by Max Schede on amputations, and shows conclusively what are the advantages of antiseptic precautions. I have simplified his statement for the sake of those of my audience who are not acquainted with medicine.

UNCOMPLICATED CASES OF AMPUTATION.

Cause of Death.	Old treatment, 377 cases.	Antiseptic treatment. 321 cases.
Blood poisoning	105	3

Thus it appears that the mortality from blood poisoning under the old treatment was 28 per cent., while, under antiseptic precautions it is less than 1 per cent.

Antiseptic measures are used in other than purely surgical cases, and my friend, Dr. John Williams, tells me that since their introduction into the General Lying-in Hospital the deaths from that terrible disease "puerperal fever," have practically ceased.

This great result has been brought about by attention to the leading principle of *principiis obsta.*

In my student days the treatment most in vogue for wounds was "pure" water; but now it is recognised that water is pre-eminently the encourager, and sometimes the main cause, of putrefaction, which of all things the surgeon tries to avoid.

The foulness of our rivers is largely due to the mixing of putrescible matter with water, *i.e.*, to water-carried sewage, and there can be no doubt that as water-carried sewage increases, the difficulty of obtaining pure water increases also. Water-carried sewage so fouled the Thames "between the bridges," that after the bitter experiences of 1854, the in-take of the water companies was moved to a point above the tide-way. Since then the population all along the Thames Valley has enormously increased, and if we who get our drinking water from the Thames escape disease, it can only be regarded as due to a happy accident, and not to the observance of any fixed principle to effectually prevent the fouling of the river. The precious liquid with which I am supplied from the Thames costs me, I think, nearly ten shillings per thousand gallons, and I need not say that I am very careful to have every drop which is used for drinking purposes both boiled and filtered.

If sewage finds its way to a water-source, I have not much faith in the various modes of "treatment" which it undergoes in those establishments which local boards love to erect for this expensive amusement.

The addition of chemicals, if in sufficient quantity to destroy living organisms, must make the water still more unpotable than before, and can only be of use by making the liquid so utterly nauseous that to drink it would be impossible.

Mere filtration cannot be regarded as any safeguard after the experience of the Lausen typhoid epidemic, in which the poison

of the fever filtered through a mile of earth, which was sufficient to check the passage of particles of wheat flour. Wide irrigation over a large area of land, as is practised in "sewage farming," is probably the best method of treating sewage, but this cannot be regarded as absolutely safe under all conditions for reasons previously indicated.

If antiseptics have been previously added to the sewage, this must increase the difficulties of "farming" with it, as, if the antiseptics have been added in sufficient quantity to destroy disease organisms, this would effectually check the growth of those other organisms upon which the fertility of the soil depends.

It is more than doubtful whether there is any absolute safety in obtaining water from deep wells. The Dudlow Lane well, near Liverpool, having a total depth of 443 feet, was fouled by percolation from cesspools, and percolation from a defective sewer would certainly prove equally disastrous. Surface wells are now not regarded as at all safe, but our suspicions with regard to them were not aroused until after the introduction of the plan of mixing water with putrescible matter. There was no soakage from an old-fashioned dry pit. There must be soakage from a cesspool or "dead well."

The only way of securing pure water is to make quite sure that there is no fouling of water-sources. If this were done, then pure water would be at once plentiful and cheap. It is now very dear, and is getting scarcer every day.

Dr. William Farr said, "a system of sewerage is the necessary complement of a water supply." For myself I should be inclined to say that an extraordinary water supply is the necessary complement of water-carried sewage, because with it our ordinary supplies quickly get fouled. In London we have effectually fouled all our wells, and the state of the Thames is such that a man must be in the very extremities of thirst or else insane before he would drink from the Thames anywhere between Teddington Lock and Gravesend. The state of our noble river is a deep reproach to us, and must remind us day by day of the serious blunders we have committed. As long as it remains as it is, we certainly have no claim to be followed as an example in matters sanitary. London should serve as a warning, as did the drunken Helot to the Spartan Youth.

The fouling of our sources of water supply has driven us far afield for water, and this no doubt has been a great cause of the lessening of our mortality of late years, but it would be unwise to talk of security because we have had no serious epidemic since 1866, an absurdly short period in the history of a nation. It must not be forgotten that pure water is as necessary for animals as it is for man, and that if we persist in

fouling our rivers the poor farmer may have to pay a "water-rate" for providing an artificial water supply for his horses, cattle, sheep, and even poultry. Many diseases of animals are communicable to man, and it is daily becoming more evident that our health is very intimately bound up with the health of our animals, and that their sanitary condition is scarcely less important than our own.

From a financial point of view, water-carried sewage has not been encouraging. It has increased the rates, increased the cost of our houses, and put us to great expense for water. The "treatment" of sewage before it is finally discharged into our rivers is everywhere an expense and nowhere a source of profit, and we find that public sewers which cost millions, cost thousands to keep them in repair.

The sewers we have built with borrowed capital. We have seized all the glory and patronage of disbursing enormous sums, and have left posterity to pay the bills. This is a doubtful policy, and I think a most immoral one, but I feel it is little use to raise my feeble voice against the custom which is now so much encouraged of hanging a debt round the neck of our successors. It may be defensible to raise a loan for building town halls, schools, and similar edifices, of which posterity will reap the benefit, but to raise loans for the purpose of wasting most valuable fertilising matter by means of works which will be a constant expense, and never a source of profit, is a very doubtful expedient.

I hope the custom will soon obtain of compelling each generation to bear the charge of its own sanitary experiments—and blunders.

Sewers are constant sources of impoverishment to the soil, and the soil be it remembered is the only *permanent* and reliable source of wealth in any country. The waste of valuable matter which takes place in London and our big towns must make us blush. I wish the waste were limited to our big towns, but it is not so. It is common throughout the country, even in rural districts. Free trade has made food very cheap indeed, and cheap food, especially *imported* food, ought absolutely to increase the fertility of a country, for obvious reasons which I need not particularize. The fertility of this country is not increasing to judge by the agricultural distress. The farmers are crying out for "protection." The first kind of protection needed seems to me to be a protection from ourselves and from the sinful waste of fertilising matters which Local Boards, Municipalities, and Imperial Parliament equally foster.

If we made a proper use of our organic refuse we should enrich posterity. As it is we reap and we do not sow. If municipalities would bury organic refuse, and plant the seed of

some forest tree suited to the soil and situation (which in these days of cheap food stuffs would probably be the best branch of agriculture to pursue), they would earn the blessings, instead of the curses. of posterity; and they would beautify the face of nature, instead of making it hideous with tall chimneys, pumping stations. and precipitating tanks. This piece of advice will, I fear, fall very flat, for of all agricultural arts, forestry seems the deadest in this country.

As a defence for gigantic sewage schemes, it is often said that you can do nothing well without co-operation, and this is the excuse for compelling all, whether they want them or not, to contribute towards the cost of sewers.

If co-operation be for a good end, the result is a great good; but if co-operation be for a bad purpose, the result is a great evil. I need say no more.

The last charge which I have to bring against water-carried sewage is a serious one, viz., that it encourages overcrowding in cities, which is universally admitted to be the greatest of all sanitary evils, and one which cannot be counterbalanced.

Water-carried sewage encourages overcrowding becauses it enables us to build houses with no outlet except a hole for the sewage to run through. The growth of London must be a source of alarm to sanitarians, and it is impossible not to admit that our system of sewers has been a most important factor in its production. Look at Charing Cross, where a street of gigantic clubs and hotels has arisen, each without curtilage of any kind, and where a handsome profit has been made by setting the first law of sanitation at defiance. You will find the same thing to a greater or less extent throughout the Metropolitan area.

It is difficult to say why we are so prone to crowd into cities. In former days we crowded behind walls as a protection from our enemies. Those days are at an end, but the crowding is greater than ever. The common cant of the day is that in this 19th century we have annihilated time and space. Certainly in cities both are excessively precious. The telegraph, the telephone, and the steam engine, ought to have diminished overcrowding, but they have not. The stream is still, mainly from the country towards the town, the attraction being the making of money and the spending of it.

It may be well to glance at the effect of this overcrowding in this city.

It is a common remark that London is a very healthy city, and as a proof of this assertion persons point to the death-rate, which certainly of late as not been excessive. The London of the Registrar-General however is a very extensive place, and many of the outlying parts are almost rural in character, so

that if you want to find the effect of living in a crowded city, it is not fair to take London as a whole.

I am no believer in the healthiness of London. It is true that our death-rate has not been raised by any great epidemic of late years, but London is undoubtedly a city where an abundance of second-rate health exists. The crowds that throng the doors of hospitals increase, and in my profession there is a great outcry about "hospital abuse," which means, I take it, that decent folk are not able to cope with the amount of chronic disorders with which they are beset. Again, the mobility of the population in the present day makes our vital statistics very uncertain. Many a healthy person is imported into London, and being wounded in the battle of life, returns to the country to die or recover as the case may be. There is a scarcity of very young and very old people, and in order to appreciate the vital statistics of London, great allowances have to be made for the abnormal age distributions.

In order to judge of the effect of over-crowding, let us look at the vital statistics of the "Strand" Registration District, which is about the centre of London, and from which one would have to walk very many miles to reach the country in any direction.

The "Strand" enjoys many advantages. It is mainly a wealthy district, extending in irregular form from Temple Bar to Buckingham Palace. It includes the whole of the Green Park and half St. James's Park. It has a gravel soil, and slopes gently, with exposure to the south, to the fringe of (potentially) the noblest river in the country. The worst and poorest parts are at the north-east corner.

The true death-rate of a London district is difficult to get. The *British Medical Journal*, however, has been in the habit for the last nine quarter-years of publishing the "true" death-rates of the London districts after complete distribution of deaths occurring in public institutions. I have compiled a table from the nine tables which have appeared in the *British Medical Journal*, so that I am able to compare "The Strand" with the whole of London for nine quarters. and with Dorset (for ten years, 1871—80).

	Birth-rate.	Death-rate.	Zymotic death-rate.	Deaths under 1 year to 1,000 births.
London	32·5	19·9	2·7	151
"Strand," and St. Martin's-in-the-Fields	23·7	21·8	2·6	192
Dorset (10 years 1871-80)..	29·53	17·46	1·68	108

I have chosen the county of Dorset for comparison because it is a "healthy district," and if we are to do any good we must always aim at a high standard. Again, the Dorsetshire labourer has always been a favourite stalking-horse for cockney politicians, and it may be well to show how much healthier he is than the Londoner, notwithstanding his supposed condition of chronic starvation.

This table is very interesting. Dr. Letheby said "a high death-rate means a high birth-rate, and a high birth-rate is the invariable concomitant of prosperity." This dictum does not evidently apply to the Strand.

Dr. Farr, on the other hand, pointed out that "a low birth-rate implies a small proportion of young adults and a large proportion of the aged." This dictum again does not apply to the Strand, as we shall see by a reference to the next table, in which I have endeavoured to make corrections for the abnormal age-distribution which obtains in that district, and which Dr. W. Ogle rightly insists is absolutely necessary before you can arrive at just conclusions.

The table, I think, speaks for itself.

"*The Strand*"—*Mean population* 1871–80 = 37,461.

AGES.	Actual numbers living at each age.	Normal age-distribution for a population of 37,500.	Difference (+ & -) between actual and "normal" numbers.	Actual deaths in 10 years, 1871–80.	Deaths which would have happened if the distribution of ages had been normal.	Death-rate at different ages.	Death-rate of Dorset	Deaths which would have happened if the death-rate of Dorset had obtained in the Strand.
Under 5	3597	5100	−1503	3596	5100	99·97	40·07	1440
5—10	3134	4500	−1366	390	548	12·44	4·31	129
10—15	3069	4012	− 943	163	212	5·31	2·79	84
15—20	3824	3640	+ 190	317	299	8·29	4·43	167
20—25	4426	3337	+1089	366	273	8·27	6·65	290
25—35	6773	5512	+1261	963	770	14·22	7·50	510
35—45	5121	4237	+ 884	1246	1000	24·33	10·48	525
45—55	3935	3225	+ 710	1338	1088	34·00	13·04	520
55—65	2311	2212	+ 99	1147	1100	49·63	24·56	565
65—75	1003	1237	− 234	754	900	75·17	55·28	550
75	268	487	− 219	425	774	158·58	151·71	403
	37461	37500		10705	12074			5203

From this table it appears that there was in the Strand during the decade 1871-80 a deficit of 3,812 children under 15, and of 453 of persons over 65, while there was a surplus of 4,233 persons between 15 and 65.

This abnormal distribution ought, according to Dr. Farr, to give as a high birth-rate, and a low death-rate. The very reverse is the case, and a critical examination of the figures seems to show that the death-rate in the Strand *is more than double what it is in Dorsetshire.*

It may be said that this high death-rate is due to the presence in the Strand of two hospitals (Charing Cross and King's College), and doubtless these have some material effect in producing the terrible adult mortality.

Hospitals, however, are generally placed where they are most needed, and I would point out that these institutions can hardly account for the enormous infant mortality; and certainly not for the deaths of infants under one year. Against the fact that the Strand contains two hospitals, is to be placed the not less important fact that it contains no workhouse. This institution is at Edmonton, where it helped to raise the death-rate from 15.8 to 16.9.

It need not surprise us that a population situated in the very centre of the vastest city the world has ever seen should have a high death-rate, and it may be well to look to the causes of death and again to compare the rates from different causes with those in Dorsetshire.

Death-rate from different causes.

	Strand.	Dorsetshire.
Whooping cough	0·62	0·29
Tabes	0·28	0·18
Phthisis	3·65	1·72
Hydrocephalus	0·61	0·22
Respiratory disease	5·92	3·15
Total of Tubercular and Respiratory disease	11·08	5·56
Small-pox	0·11	0·09
Measles	0·36	0·20
Scarlet fever	0·49	0·33
Enteric	0·38	0·19
Violence	1·61	0.49
Diarrhœa	0·92	0·35

No good would be got by extending this table. Suffice it to say that there is no single cause of death in the Registrar-General's tables which is not more active in the Strand than it is in Dorsetshire.

I would particularly draw attention to the fact that the death rate for whooping cough and tubercular and respiratory

diseases for the Strand is more than double that of Dorsetshire, a fact which is not to be wondered at in a population, the bulk of whom only breathe pure air upon the rarest occasions, and who habitually breathe an air so foul that the sun often fails to penetrate it, and which is fatal to almost all flowers and a large proportion of trees.

To me one of the saddest indications of the dismal state of this overgrown city is the appeal, which is now so common in the newspapers, for funds to give poor London children *one* day in the country, with of course the not immaterial deduction of the hours spent in going and returning.

These tables may serve to dispel another popular fallacy, viz., that the sulphur-laden air of London has antiseptic powers, and helps to check zymotic disease.

As a fact those zymotic diseases which presumably travel through the air (Small-pox, Whooping Cough, and Measles), are particularly rife in London. The death-rate from these three causes was during 1871-80:—

	In London.		Dorsetshire.
Small-pox ...	0·44	...	0·09
Measles ...	0·51	...	0·20
Whooping cough	0·81	...	0·29
	1·76		0·58

In fact the mortality caused probably by air-borne germs was exactly three times as great in London as in the healthy country district which I have chosen for comparison.

I have endeavoured to show that the admixture of water with putrescible matter is inadmissible.

1. Because it is antagonistic to a law of nature, encouraging putrefaction and delaying nitrification, and there can be no successful antagonism to nature.
2. Because the putrefaction set up in cesspools and sewers by mixing water with putrescible matter has been a direct cause of much disease.
3. Because the practice involves the most perfect dissemination of disease particles, and a neglect of the great principle, "*principiis obsta.*"
4. Because it is the great cause of the fouling of rivers and wells, and makes the obtaining of pure water increasingly difficult.
5. Because it is financially and economically disastrous, crippling the ratepayers and exhausting the land.
6. Because it is one of the chief causes of overcrowding, the greatest of all sanitary evils.

It may be asked, "What useful purpose can be served by talking thus to an audience of Londoners? London is hopelessly committed to the principle of water-carried sewage, and must make the best of it."

To this I reply that even London need not needlessly increase her already insurmountable difficulties, and that happily the whole of England is not yet quite absorbed into London and other cities. There is a very general belief throughout the country that because London has adopted the system of water-carriage it must therefore be the best. This idea is unthinkingly adopted, and to its adoption the distinction of borrowing and disbursing a large amount of other people's money acts as a spur. There has come within my own knowledge the case of a country town, in the midst of a poor agricultural district, which clamoured for a "sewage scheme" for the purpose of polluting its sparkling water-course, where anglers pay large sums for the privilege of trout-fishing; its death-rate being at the time between 16 and 17.

In the Thames Valley, the region of villas and market gardens, a whole crop of "sewage schemes" have lately been put forward, notwithstanding that the more rational methods of sanitation would be easier and cheaper.

Only the other day I visited a lone farm-house which a friend wished to take for the summer, and I found that the proprietor, having taken the soil-pipe of a recently erected water-closet into a cesspool alongside a deep well sunk in the chalk, had rendered his house unlettable to any thinking person, and lastly I heard last week of a friend who took a moor in Scotland, and wished to have rational methods of sanitation, but the noble owner, bitten by the modern craze for water, would allow nothing but water carriage, and accordingly laid his filthy pipes to foul the babbling highland burn, and deprive the soil of that of which it was in need.

Again, in institutions such as workhouses, barracks, schools, and the like, water-carriage is often adopted, notwithstanding the favourable conditions for rational methods. The ignorance of soldiers in this matter is an acknowledged cause of the sickness and mortality during campaigns.

There seems in short a very great necessity for directing attention to the "shortcomings" of water-carried sewage.

What do you propose? will be the next question. My answer is fair play and no compulsion.

Much as I believe in the good of spreading sanitary knowledge, I have little faith in the efficacy and a potent belief in the dangers of sanitary legislation whereby blunders are stereotyped.

The first thing necessary is an equitable adjustment of sanitary rates.

Borrowing for the purpose of constructing sewers should be disallowed, and those who do not need the sewers should not be called upon to contribute towards them at least not to the same extent as others.

The present inequitable adjustment of sewer rates, is a premium on jerry-built houses without curtilage. Encourage the man who has a little bit of garden to make use of it.

Enforce the Pollution of Rivers Act against individuals, even against proprietors of highland moors.

Let us have a real inspection of nuisances and a harrassing of evil doers, and let us discourage by every means in our power the building of houses side by side and almost back to back, with no outlet but a hole.

Let water be paid for by meter.

I have every sympathy with the agitations of getting allotments for the poorer classes. The best and most economical allotment is one close to the house where refuse may be buried and in due time bring forth.

Those who advocate "sewage farming" tell us that an acre is necessary for every 100 inhabitants. How infinitely better if the 100 people could absolutely live on the acre of ground in (let me say) 20 cottages, each cottage having $\frac{1}{20}$ of an acre. How infinitely better for the man to till this little plot in his spare time, than to occupy his leisure by braying politics in a publichouse.

Let us calculate the produce of this plot of ground in terms of potato. An acre of a field will produce an average crop of 7 tons; the twentieth of an acre would produce 7 cwts., or 784 lbs. As these would be for home consumption, and would save the man from disbursing money at a retail shop, we may take the value at the average retail price of 1d. per lb., or £3 5s. 4d., or for the sake of simplicity say £3. To give $\frac{1}{20}$ of an acre to every five inhabitants would make a town inconveniently big it may be said. I think not; 100 to an acre is 64,000 to a square mile, or making a very liberal reduction for space occupied by roads, let us say 50,000 to a square mile. This does not sound like an inconvenient scattering of houses. The inhabitants would make £30,000 a year by the produce of the land, a gain of which Free Trade could not deprive them; and there would be no sewer rate, no plumbers' bills, and certainly a vast increase of health, happiness, and contentment.

What I am advocating is no utopian scheme, and I am not talking without some practical experience. A few years ago I bought twenty cottages adjoining a garden which I have in the

country. Many of them had been built with a very insufficient curtilage, and their old fashioned sanitary arrangements made the garden anything but pleasant. My first step in improving these cottages was to do away with the old fashioned pits, which were not suited to the low-lying spot and were always full of water, and replace them by pails. The cottages are systematically scavenged every day, and all refuse, inclusive of food refuse, excrements, and ashes, are buried immediately in the garden. There has been a complete cessation of all offence, and my garden holds the proud position of being certainly one of the most fertile in the district. Roses and other flowers, and all the ordinary garden fruits and vegetables, flourish therein in great luxuriance. The æsthetic aspects of the place have been increased, and in no way diminished, by the course I have pursued. I wish it to be understood that I am no mere theorist, but that I practice what I preach.

I have dealt with this subject from rather a different point of view in a little book, "Our duty in regard to Health," which I wrote for the Council of the Health Exhibition. Those who may care to pursue this subject further, may get the book of Clowes & Co., the publishers, at Charing Cross.

KENNY & CO., Printers, 25, Camden Road, Camden Town, N.W.